A Discrete Simulation of Systemic Factors In Determining The Zooplankton Sensitivity to Electromagnetic Radiation

Introduction

Today, as a result of increased global climate changes, it is quite reasonable to make some revision of the well known Commoner's Law: "Nature knows best". In fact, monitoring the status of ecosystems should be complemented with measures of their controls. Specifically, regarding man made ecosystems, which have no established evolutionary mechanisms for the maintenance of homeostasis. For instance, the water reservoir-coolers for the nuclear power plants, which have a role in the energy sector as a growing relation and importance to technologies that do not produce gaseous emissions, therefore, do not cause greenhouse effect. Consequently, we need a wide range of ecosystem control methods. And among these methods, the application of electromagnetic radiation should play an important role. Natural analogies of such methods can be an influence by geomagnetic field disturbance upon natural ecosystems. This influence is confirmed by recent investigations [1-4] concerning communities of water animals, it was established [3-4] that the effect of such influence is related to dynamical systems of these communities, which determine homeostasis. Therefore, it is necessary to enlarge the range of methods by mathematical modeling, which will allow for a working hypotheses concerning the structure of casual and feedback ties to determine the state of homeostasis, and later, based on these hypotheses, to choose an optimal strategy of influence upon ecosystems. The method of Discrete Modeling of Dynamic Systems with feedback (DMDS), developed at V.N. Karazin Kharkiv National University [5], applied earlier to specific biological problems [6, 7] are included in the set of power simulation tools. It allows, on the basis of correlation relations (correlation matrix) of observed data revealing the most probable structure of between-element and intra-element relations of multi-component dynamic systems of different nature. Earlier, we mentioned about six types of between-element relations ("zero-zero", "plus-plus", "minus-minus", "plus-minus", "plus-zero", "minus-zero") and three types of intra-element relations ("zero-zero", "plus-plus", "minus-minus"). This article is investigating systemic factors which determine the sensitivity of Lake Zooplankton to electromagnetic radiation caused by geomagnetic field disturbance with the help of DMDS.

Methods

We used data extracted from the literature [8], describing dynamics of Zooplankton from Lake Seven (Armenia) from 1958-1969, the months April - September of each year inclusively and frequencies of geomagnetic field disturbances [9] from corresponding periods of time. From this period, two sub-periods were selected, described below, in the "Results" section. For these sub-periods with the assistance of DMDS (weight function methods) the structure of relations between the following species, belonging to main systemic groups of freshwater zooplankton, were revealed:

- Keratella quadrata (Rotatoria),
- Filinia longiseta (Rotatoria),
- Cyclops strennus sevani (Copepoda),
- Daphnia longispina sevanica (Cladocera.)

With the help of DMDS, some working hypotheses concerning the systemic factors, which determine a difference between sensitivity of zooplankton community to electromagnetic radiation for these sub-periods, were obtained.

Results

The entire period 1958-1969, was divided into two sub-periods, related to biomass peaks of Cyanophyta. The first of these sub-periods lasted four years 1958-1961, immediately before registration of the first biomass peak of Cyanophyta. In this period there exists a positive and statistically significant (p 0.05) correlation between the frequency of geomagnetic field disturbances and biomass of Daphnia longispina sevanica. For these two sub-periods and with the help of DMDS, we obtained the most probable relationship between the above mentioned four species. The structures are essentially different by many relations, but we highlight here the most important, in our opinion, differences between the mentioned sub-periods.

a) There exists an internal competition for Keratella quadrata, Cyclops strennus and Daphnia longispina within the second sub-period and no such competition for these species in the first sub-period.

For Filinia longiseta the situation was reverse;

b) There is no external negative influence on Daphnis longispina within the second sub-period, but there was influence from Keratella quadrata (relation "zero-minus") in the first sub-period.

This difference in the structural relationship suggests a working hypothesis, according to which a positive correlation between the frequency of geomagnetic field disturbances with Kp-index greater and equal to 6 and less 7 and biomass of Daphnia longispina in the peiod 1958-1961, exists due to the weakening of competitive pressure on this species as a result of negative influence of electromagnetic radiation on its competitor Keratella quadrata. There are models [10], describing such an effect for one-stage suppression of one of competitors. Perhaps, in the period 1958-1961, similar effects have larger importance than the direct negative influence of electromagnetic radiation on Daphnia longispina, while in the period 1962-1969, such direct negative influence of electromagnetic radiation on Daphnia played a greater role. Taking into account the amount of nutrients in the water of Lake Seven for the entire observation period had been steadily increasing (note, a weakening of food competition in 1962-1969, could have caused this result), such a working hypotheses seems to be grounded.

Discussion

The use of DMDS for the working hypotheses generated in the framework of the present work allowed for new ways to consider some aspects of homeostasis mechanisms of freshwater zooplankton. Specifically, the aspects of sensitivity of plankton to factors related to geomagnetic field disturbances. We can assume that these results will have both theoretical and practical significance in approaching the development of methods for water ecosystem controls.

Conclusions

The current work obtained results from DMDS, which may be useful for the development of strategies for water ecosystem controls by electromagnetic radiation in conditions of sharp global climate changes.

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